

Top capital spenders

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Europe's green electronics

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Home automation

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Electronic Business

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES—WORLDWIDE

AUGUST 19, 1991



AT&T Microelectronics bets a billion

PAGE 28

William J. Warwick, president
of AT&T Microelectronics

Electronic Business

VOLUME 17, NUMBER 16

FOR THE MANAGEMENT TEAM IN ELECTRONICS, COMPUTER, AND SYSTEMS COMPANIES-WORLDWIDE

AUGUST 19, 1991

Cover photo by Jeffrey Vock



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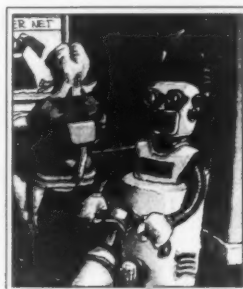
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ART STAFF

Art Director: Michael Roach
Associate Art Director: Elizabeth Zisa
Staff Artist: Michele G. Kane

EDITORIAL OFFICES

Boston: Cahners Building
 275 Washington Street, Newton, MA 02158
 (617) 964-3030 Telex: 94 0573 CPC BSN
 Fax: (617) 558-4327 MCI: EBBOS
San Jose, Calif.: Hugh G. Willett,
 Teri Sprackland, David Webb
 Sherman Building, 3031 Tisch Way, Suite 100,
 San Jose, CA 95128 (408) 243-8838
 Fax: (408) 243-2144
Northwest: Dwight B. Davis
 11020 86th Ave. NE
 Kirkland, WA 98034 (206) 820-5741
London: Barbara N. Berkman
 27 Paul Street
 London EC2A4JU England 011-44-71-628-7030
 Fax: 011-44-71-628-5984

PRODUCTION

VP Production: Wayne Hulitzky
Director of Production/Manufacturing:
 John R. Sanders
Production Supervisor: Andrew A. Jantz
Production Assistant: Julie T. Kohn,
 (617) 964-3030

CIRCULATION

Circulation Manager: Ann Ward
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INSIDE BUSINESS

How companies are learning hard lessons

WHAT DO marketing, capital spending, and industrial recycling have in common? Simply this: In all three areas, electronics companies are proving they can overcome their past errors.

Exhibit A is AT&T Microelectronics. The division stumbled badly a few years back as it tried to enter a major market, merchant semiconductors. False starts and a technology-first, market-last philosophy created a credibility crisis among potential customers. But as Teri Sprackland and Lewis Young report in our cover story, there have been major upgrades in market awareness at AT&T Microelectronics.

Those changes start at the top, with a new management team that defies AT&T tradition by tapping outside talent. Those new managers are working to create a corporate culture based on close ties with customers, both inside and outside AT&T's core communications businesses. That means asking customers' advice on product development and building trust among microelectronics prospects who compete with AT&T in other areas.

Now let's look at Exhibit B—"B" as in budgets and, specifically, as in budgets for capital spending. An exclusive ELECTRONIC BUSINESS rank-



Editorial assistant
Quang Bao

ing of the top 100 capital spenders in the U.S. electronics industry reveals a surprising trend: Despite declining profit growth in fiscal 1990, the top 100 increased investment in new plants and equipment. Furthermore, despite the impact of the current recession, electronics executives say they expect to boost capital spending next year.

Harder still, across all industries, has been the lesson of environmental responsibility. In Europe, companies are under special pressure to reduce pollution by recycling their products and the hazardous materials they contain. Senior editor Barbara Berkman provides an in-depth report on how the top European electronics companies are responding, with stateside reporting help from editorial assistant Quang Bao.

Vietnamese-born Quang is a recent addition to the ELECTRONIC BUSINESS staff. Along with canvassing U.S. electronics companies on environmental safety, he's done extensive research for articles on executive compensation and for our upcoming issue on quality. A recent Boston University graduate, he joins the staff as a recipient of a six-month Cahners President's Fellowship.

—John Parker

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SEMICONDUCTORS

Uncle Sam still rules the mixed-signal markets

DESPITE LOSS OF share in most other semiconductor markets, the Stars and Stripes are still flying high over the fast-growing mixed-signal chip market, according to a new report from VLSI Research Inc.

In sharp contrast to the Japanese-dominated memory chip markets, U.S. companies hold 6 of the top 10 places (including the top 5) on the 1990 VLSI rankings, says Gus Richard, market analyst at the San Jose-based firm. National Semiconductor, Texas Instruments, and Analog Devices, respectively, retained their top three places on the list from 1989; Motorola and Harris swapped fourth and fifth places, with Motorola's 34% annual sales growth leading the top 10.

Only two Japanese companies (not counting Japanese-owned, U.S.-run Silicon Systems Inc.) made the top

10 list. Silicon giants NEC and Toshiba each dropped a place in the list, falling to 7th and 10th, respectively. "We just don't see the Japanese in this market," Richard notes. "What little mixed-signal technology they do have is mostly for internal use."

The U.S. hold on the market is historical—the country has been in analog design for over 30 years—and analysts say it's unlikely to change soon. Most chip companies, especially in Japan, have focused on digital technology for years, leaving analog design to niche suppliers.

The growth in mixed signal is driven by the need for higher integration in systems that have traditionally used discrete analog and digital chips, notes Richard Sessions, director of marketing for analog/digital technology at National. Disk

drives that used 100 chips a few years ago use just 16 today, for example, and will use only 4 by 1995.

Analog design is the key to the mixed-signal market, explains Sessions. "You need the heritage in analog to win in mixed signal," he says. "You can't go to Cornell and MIT and find people interested in learning analog." He adds that automated design tools, which have taken the mystery out of digital design, are about 10 years ahead of analog tools.

And the mixed-signal market will remain a good opportunity for U.S. manufacturers. With a compounded annual growth rate of over 20% through 1995, mixed-signal chips will outpace the overall semiconductor industry growth rate, says VLSI, offering hope for U.S. chip makers targeting growth markets such as fax machines, LANs, and hard-disk drives. VLSI predicts that the market for chips that combine analog and digital signals on the same chip will more than double, from \$5 billion in 1991 to \$10.6 billion by 1995.

A special advantage for U.S. chip companies selling into the disk drive markets is the fact that U.S. companies dominate the small-form-factor hard drive markets. "Almost all the chips are made for custom applications and then sold as standard parts," says VLSI's Richard. "It helps to be close to your customers when developing these application specific parts."

—Hugh G. Willett in San Jose

Top ten mixed-signal suppliers

(\$ millions)

1989 Sales

	National Semiconductor \$340.6
	Texas Instruments \$321.8
	Analog Devices \$228.9
	Harris Semiconductor \$163.6
	Motorola \$142.9
	NEC \$134.3
	Silicon Systems* \$124.4
	Rockwell \$123.0
	Toshiba \$121.0
	SGS Thomson/Microelectronics \$109.7

1990 Sales

	National Semiconductor \$426.1
	Texas Instruments \$394.5
	Analog Devices \$271.6
	Motorola \$190.9
	Harris Semiconductor \$185.0
	Silicon Systems* \$165.1
	NEC \$148.8
	Rockwell \$140.4
	GEC Plessey \$138.6
	Toshiba \$131.5

*Silicon Systems is a U.S.-run company owned by TDK, a Japanese company.

Source: VLSI Research Inc.

INFORMATION SYSTEMS

Federal agencies to cope with five-year slump

IF YOU THINK planning your company's capital budget is easy during a recession, try working for the government.

Despite ever-growing information needs, a cap on spending means slow growth ahead for government purchases of information systems. According to the Electronic Industries Association in Washington D.C., federal obligations for computers and

other information-related hardware, software, and services will grow just 0.7% per year after adjusting for inflation, from \$22.3 billion in fiscal 1992 to \$22.9 billion in 1996. That growth rate is down from the trade association's previous five-year forecast of 1.5% annual growth for 1991 through 1995.

Many of the cuts will come in defense spending, but the civil sector is expected to hike spending for information systems 3% per year (after inflation) over the next five years. As a result, the top three buyers of information technology will be the Transportation Department, the Treasury Department, and NASA. Also, the amount of the federal information technology budget that will be spent on outside contractors is expected to grow nearly \$1 billion over the next five years; by then, funds for contractors will represent 74% of total federal information systems spending.

George Shaw, director of planning for Hughes Information Technology Co. in Reston, Va., says there is another bright side to the EIA slow-growth forecast. "Since the forecast was released last spring, we've learned the FBI will be spending more on information systems for the National Crime Information Center

and another program," he says. For vendors, of course, that's welcome news. For criminals, however, it may be another story.

—Elizabeth B. Baatz

RUGGEDIZED COMPUTERS

Codar patent stirs DOD computer market

HAS A SMALL Colorado company cornered the market for ruggedized computers?

Codar Technology Inc. of Longmont, Colo., has been awarded a patent covering "the general design concepts of ruggedized computers and workstations," according to the company. Ruggedized computers, built with special enclosures, ventilation systems, and shock-prevention gear, are designed for use in military vehicles, on factory floors, and in other harsh environments.

Ruggedized computers are a rapidly growing market, given that the Pentagon is buying more commercial computers adapted to military use instead of mil-spec computers designed specifically for military applications. This fiscal year, the U.S. Department of Defense is expected to buy more than \$1.5 billion worth of commercial computers, of which ruggedized systems make up a sizable chunk.

Codar, with annual sales of \$20 million, buys computers from Digital Equipment, Sun Microsystems, and Motorola, then rebuilds and sells them for use in missile-launching systems. Although Codar president Mike Evans says the patent "appears to be very broad" in scope, he declined to speculate on its impact on other ruggedized computer suppliers.

Vendors and industry-watchers are scratching their heads over the patent's potential impact. Builders of ruggedized computers range from such giants as Raytheon to smaller companies such as Rugged Digital Systems and Cyberchron. A Cyberchron spokesman says any impact

will hinge on just how the patent defines ruggedized computers.

If the scope of the patent is as broad as Codar hints, "It could really turn into a nasty fight," says analyst Brett Lambert of Defense Forecasts.

Under law, companies that supply ruggedized computers to the military cannot be stopped from building those computers even if judged to be in violation of Codar's patent. But Evans says that those companies could be required to pay royalties to Codar for use of the patented design.

—Rick Whiting

STRATEGIES

Is Plessey/SGS alliance the prelude to merger?

GEC PLESSEY Semiconductors and SGS-Thomson Microelectronics have agreed on a joint development program for semicustom ICs—the first step in a continuing program for semiconductor research and development.

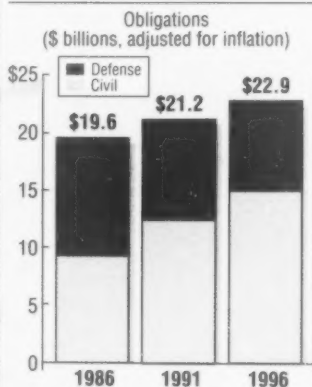
The alliance, announced last month in Paris, standardizes both the cell libraries and the 0.7-micron CMOS process of the two companies. Under the "precompetitive" agreement, the companies will share R&D costs but will not market jointly.

The intense price pressure of the ASIC market has many companies struggling to maintain margins. GPS and SGS-Thomson, in agreeing to divide research costs and standardize their process and cell libraries, have in one stroke halved their R&D expenses—a move that could improve both companies' competitiveness.

Both Doug Dunn, GPS managing director, and Philippe Geyres, corporate vice president and general manager of SGS-Thomson's programmable products group, alluded to recent comments by Pasquale Pistorio, president and CEO of SGS-Thomson, about the desirability of his company's merger with another European semiconductor company. Both executives, however, denied that merger discussions were under way.

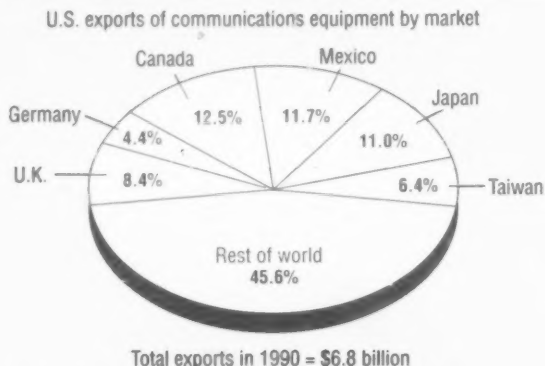
GPS is adopting SGS-Thomson's

How the government buys info systems



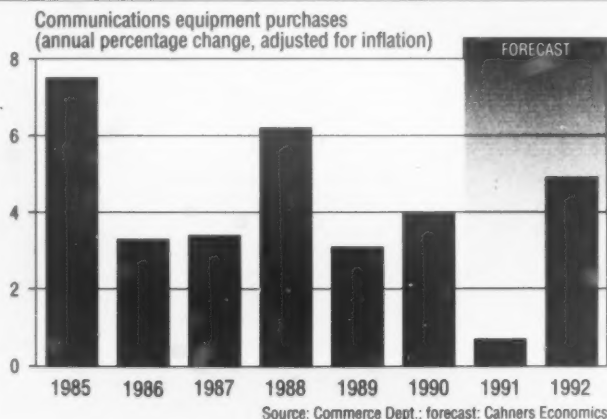
Source: Electronic Industries Association

Offshore buyers helped sales last year...

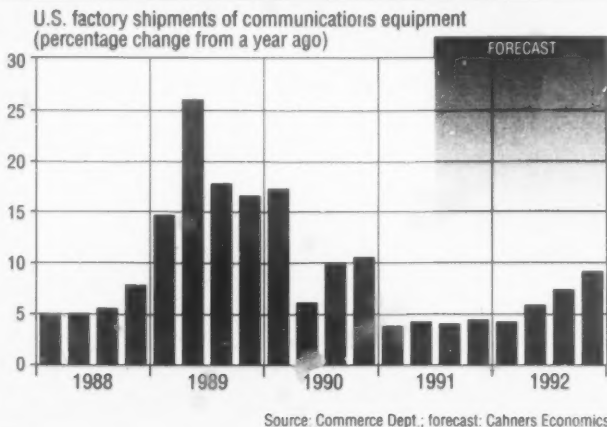


Source: Electronic Industries Association

...and U.S. buyers promise an even better '92...



...which bodes well for industry shipments



Communications equipment sidesteps the recession

LOW BUSINESS confidence during the Persian Gulf crisis took its toll on capital-spending plans, including purchases of communications equipment. In the first quarter of this year, U.S. business doled out an annualized \$51.3 billion for communications equipment—a 1.6% increase from a year ago. That measly increase shrivels up once inflation is taken into account. In constant dollars, investment amounted to \$38.7 billion, a drop of 1% relative to first-quarter 1990.

More recently, however, higher sales, improved profits, and an easing of the credit crunch should mean a return to more moderate investment growth in communications equipment. So do not expect a repeat of the retrenchment that took place during the recession of 1982 and 1983, when inflation-adjusted purchases of communications equipment declined from year-ago levels for seven consecutive quarters. This time around, Cahners Economics expects slow but increasing growth for U.S. business investment in communications through early 1993.

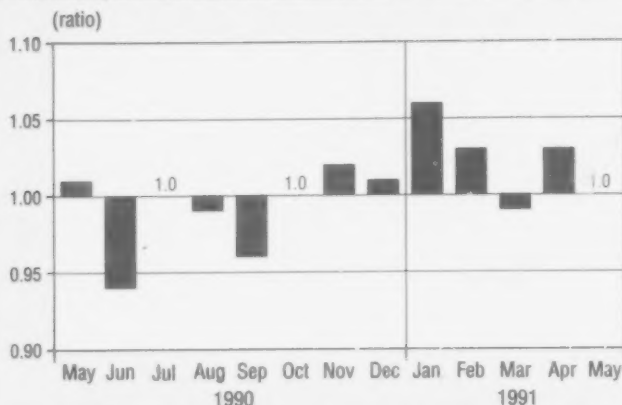
Nevertheless, U.S. manufacturers can expect to feel at least a moderate pinch because of fewer offshore sales. Last year, total exports of communications equipment came in at \$6.8 billion. Both Canada and Britain have fallen on hard times lately, however, and economic growth has slowed even in Japan and Germany. Furthermore, the U.S. dollar's sharp gain since the beginning of the year could crimp exports for a while.

Due to a lagged response to the early 1991 recession, U.S. factory shipments of communications equipment are expected to increase by only 4.1% this year, on the heels of a robust 10.8% rise in 1990. Next year, shipments will grow 6.6% as the recovery takes hold.

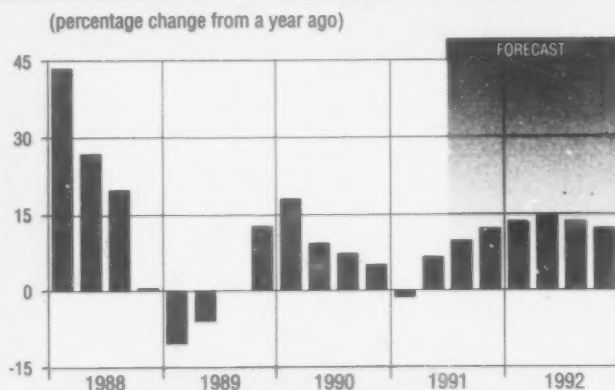
—By Madeline Franchi

BUSINESS BAROMETER

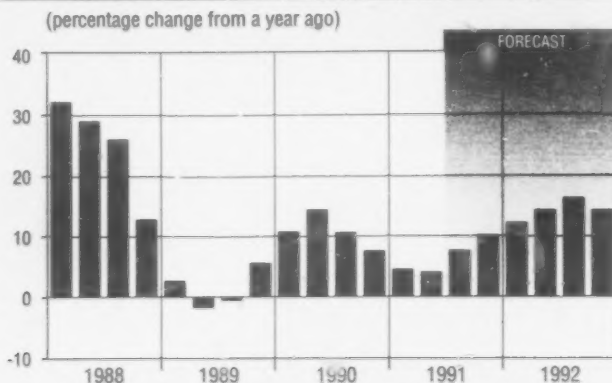
Distribution's book-to-bill lingers low...



...but optimistic second-quarter bookings...



...suggest better billings growth ahead



Note: Second quarter figures are estimates based on two months of actual data.
Source: National Electronic Distributors Association; forecast: Cahners Economics

Distribution forecast still looking relatively rosy

AFTER A FEW years of speculating if and when the recession would start, forecasters can turn to a more gratifying chore: Identifying the beginning of the next expansion. Getting enough sectors of the economy over the recessionary hump so the overall economy can grow steadily again has been an agonizing process. Unlike the harder-hit financial and housing industries, however, the electronics distribution industry has managed to stay afloat.

So far distributors have held onto a steady 4% shipments growth rate in the first half of 1991. Even though the book-to-bill ratio for the nation's largest distributors hasn't risen lately to an acceptable comfort level, neither has the ratio fallen through the floor.

After slipping 1.3% in the first quarter of 1991 compared with the year-ago level, distributors' bookings rebounded with 9.3% year-ago growth in April and a 6.1% gain in May. In fact, Cahners Economics expects distributor orders to see encouraging gains during every remaining quarter this year and next.

Shipments also expanded at a 7.1% rate above year-ago levels in May 1991 (the highest year-ago growth rate in the past five months). It appears that the low point for shipments growth occurred in the second quarter of this year. A few more months of positive data this fall should confirm the trend. The distribution billings forecast remains unchanged at 6.5% for 1991. We're more optimistic about distribution in 1992 and predict a 14% growth rate for the year.

—By Julie Handelman

For more information on Cahners Economics' forecasting services, contact Dan Buchan at (617) 630-2105 or by fax at (617) 630-2100; or write Cahners Economics, 275 Washington St., Newton, MA 02158

T O P

100
CAPITAL
SPENDERS

Capital spending holds on

Even with the recession, the top spenders did alright in 1990 and plan to invest big bucks in '92

By Elizabeth B. Baatz and Linda Stallmann

When profits plummeted in the 1985 recession, capital-spending budgets for the top 100 capital spenders in the electronics industry jackknifed too. Not this time. Saved by a surge in fiscal 1990 profits, the double-digit profits drop in 1989 failed to seriously cut into capital budgets.

In fact, capital investments by the top 100 spenders rose 7% in fiscal 1990, to a record-breaking \$20.3 billion in nominal dollars. Excluding IBM (which accounted for nearly one of every three dollars spent by the top 100), capital spending actually jumped 10%. Last year's gain followed on the heels of a mere 3% rise in capital spending growth and a 27%

profit slide in 1989.

Another reason capital spending did not contract in 1990 was simple necessity. Even with a 4% decline in sales during 1990, for example, components manufacturer CTS Corp. still managed to increase capital spending by 9%. The total quality movement led the Elkhart, Ind., company to reevaluate factory layouts for efficiency and the need to broaden its foreign presence drove CTS to invest in new factories abroad. While CTS was an exception to the rule—most companies with falling sales cut back capital spending—the 63 companies that increased their capital spending budgets in 1990 more than offset the 37 companies that cut them.

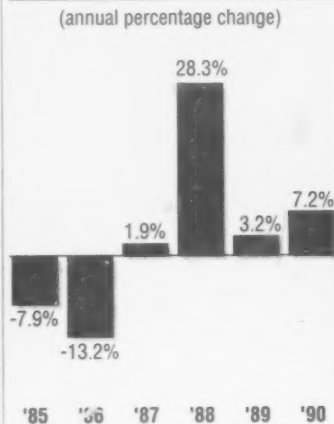
But not all trends are up. While dollars committed to new plant and equipment continued to grow last year, capital spending as a percentage of total sales for the 100 top spenders receded to 7.8% last year, from 8.3% in 1989 and from a peak 11.2% spending-to-sales ratio in 1984.

HOW MEANINGFUL are these capital spending-to-sales ratio trends? The sensationalist may imply that a falling ratio demonstrates that short-sighted U.S. companies are not investing in adequate capital equipment for the future. And compared with Japan, the numbers don't look good. According to Lawrence Krohn, senior economist for Shearson Lehman Hutton in New

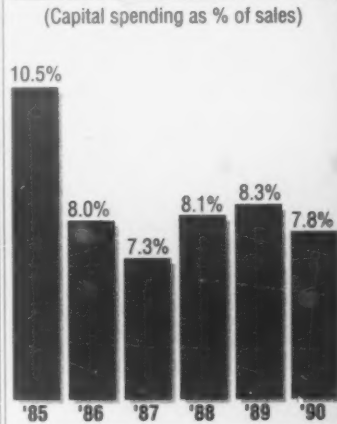
Capital spending tops the \$20 billion mark...



...and escapes a repeat of the '85 & '86 cuts...



...but fails to capture growing share of sales



Source: ELECTRONIC BUSINESS

T O P 100 CAPITAL SPENDERS

Some industries keep investing, others cut back

Capital expenditures in fiscal 1990

Industry (number of companies)	as % of sales	\$ millions	% change from 1989
Semiconductors (12)	13.6%	\$3,631.2	8.5%
Communications (9)	10.4	1,458.2	8.2
Components (7)	9.9	526.6	-1.9
Mainframes (10)	8.7	7,908.8	-0.4
Minicomputers (6)	8.3	1,608.3	-10.6
Diversified (7)	8.3	8,404.3	2.8
Software (10)	7.6	456.2	22.0
Computer-based systems (4)	7.1	1,007.9	2.4
Government (10)	6.8	2,741.8	46.2
Desktop computers (5)	6.7	871.2	-9.8
Medical equipment (5)	6.3	170.5	36.2
Peripherals (7)	5.9	425.3	15.0
Office equipment (3)	4.7	803.0	6.6
Instruments (7)	4.3	466.6	-1.8
Consumer (2)	2.5	144.9	-7.5
Distribution (3)	1.7	49.1	NA

Note: Some companies are included in more than one industry. See main tables for categorization of each company
NA = Not available

Source: ELECTRONIC BUSINESS

York, Japan spent roughly 20% of its GNP on machinery and equipment last year, while U.S. industry spent just 12%. Comparisons between the U.S. and Asian electronics industries look just as bad.

While the U.S.-Japan capital-spending gap continues to receive attention, there is little focus on the end result of all those dollars and yen spent. The bottom line, however, for all this capital equipment investment is to improve one's competitive position in order to reap more profits down the road. The top 100 U.S. electronics company capital spenders did manage to hike their profits 26% collectively in fiscal 1990, while increasing capital budgets at the same time. Profits from all top 200 U.S. electronics companies, which include a significant share of non-electronic operations for many

conglomerates, actually fell slightly in calendar 1990.

Steve Pavlech, manager of technology planning for Hamilton Standard, a division of United Technologies in Windsor Locks, Conn., points out that the interpretation of capital spending-to-sales ratios is changing.

The biggest budgeters

(% of sales)

Advanced Micro Devices	28.7%
Micron Technology	24.0
Applied Materials	19.6
Sequent Computer	19.0
Intel	17.3
Integrated Device	16.7
Cypress Semiconductor	16.2
Tandem Computers	16.1
Teradata	15.3
Pyramid Technology	14.3

Source: ELECTRONIC BUSINESS

For example, says Pavlech, "companies like Hamilton Standard are scrutinizing working capital very hard to make sure they get maximum effectiveness for every dollar spent." As electronics companies improve the way they utilize their funds, including using more industry consortia and tapping into federal dollars for improving manufacturing technology, the capital spending-to-sales ratio could be falling partly because each dollar is being spent more wisely.

THE BIG SPENDERS in the electronics industry, of course, are semiconductor companies. According to ELECTRONIC BUSINESS's ranking of the top 100 spenders, the 12 semiconductor companies on the list spent a collective \$3.6 billion in fiscal 1990, or 13.6% of their sales, on capital equipment. Despite a cut in spending by 5 companies—including National Semiconductor and Micron Technology—the group increased capital spending a respectable 8.5% last year. Overall, chip makers spend more money on plant and equipment for every sales dollar generated than any other segment of the electronics industry.

Other industry segments that have been accelerating equipment purchases include military and government electronics suppliers, medical equipment makers, software, and peripherals companies. The latter three make sense, as these segments have the best sales growth to support their expansion.

In the government sector, a 46%

The smallest budgeters

(% of sales)

Avnet	1.0%
Perkin-Elmer	1.7
Computer Associates	1.8
Control Data	2.3
Zenith Electronics	2.3
Premier Industrial	2.3
Tandy	2.5
Marshall Industries	3.1
Xerox	3.3
ESCO Electronics	3.3

Source: ELECTRONIC BUSINESS

TOP 100 CAPITAL SPENDERS

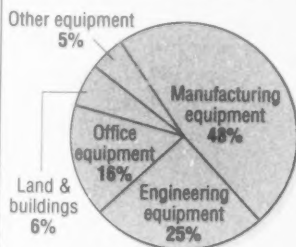
gain in capital spending from 1989 to 1990 is slightly deceptive because two large companies, Raytheon and Litton Industries, which were excluded from the ELECTRONIC BUSINESS ranking in past years, were added to the capital spending ranking for the first time this year. (The methodology note below explains why.) Still, the need to invest in new environmental controls and intense competition in a shrinking military market explain much of the defense sector's increasing capital budgets.

Chances are, because capital spending typically lags a recession, plans for increasing capital budgets have been curtailed somewhat in early 1991. Next year's exclusive ELECTRONIC BUSINESS ranking of the top 100 capital spenders in the U.S. electronics industry will chronicle those results. Evidence from the U.S. Commerce Department on capital expenditures by all industries shows a spending slowdown has been in effect so far this year.

Anecdotal evidence suggests that the recession did not hit capital budgets in 1990 but will impact spending in 1991 as well. Take

Where are the dollars going?

(Capital spending in 1991 by U.S. electronics companies)



Source: ELECTRONIC BUSINESS

Looking forward, a special survey of 46 financial officers in the electronics industry shows that spending plans for 1992 are full steam ahead. According to the ELECTRONIC BUSINESS survey, these CFOs expect to pump up collective capital spending budgets by 28%, from an average \$3.8 million in 1991 to \$4.8 million in 1992. As a percentage of sales, capital spending is budgeted to increase from 5.8% to 6.7%.

Capital spending was a driving force in the latter part of the last economic boom in 1988 and 1989 and will continue to be the engine to growth in the next upswing. Even though the upcoming recovery is expected to be mild by historical standards, capital spending growth should outrace overall economic

the case of Chestnut Ridge, N.Y.-based instrumentation maker LeCroy Corp. Says LeCroy's chief financial officer and vice president of finance, Joseph J. Migliozi, "This recession sort of snuck up on us. In the past when we saw a recession coming, we could throttle back on capital spending and other spending. This time we took longer to react and were a bit late in turning spending off."

growth. One reason for the need to continue investing in plant and equipment is competitive pressure from abroad. In fact, half of all the dollars spent on plant and equipment by those CFOs polled by ELECTRONIC BUSINESS are buying manufacturing equipment. Also, a third of these companies are investing in foreign operations, particularly in Western Europe, as they gear up for the unified European market.

Still, not everyone is buying capital equipment to compete in the high-tech wars of the future. One CFO in the survey admits that an office manager at the company has put in a request for an old-fashioned typewriter. So much for all that high-brow PC software! For the rest of the industry, increasing capital spending regardless of weak sales will continue to be an overriding challenge. □

This ranking of the top 100 capital spenders includes those publicly owned companies from the ELECTRONIC BUSINESS 200 list that spend the most money on capital investments and that also generate 50% or more of their total revenue from electronics sales. In previous years, the top capital spenders had to generate 70% or more of their total revenue from electronics to be included in the top spenders list. The latest data have been gathered from company annual reports for fiscal 1990.

The biggest spenders

(\$ millions)

IBM	\$6,509
Motorola	1,256
Digital Equipment	1,028
Hewlett-Packard	955
Texas Instruments	909
GM Hughes Electronics	884
Intel	679
Unisys	460
Xerox	444
NCR	402

Source: ELECTRONIC BUSINESS

The biggest gainers

(% rise from 1989)

Cadence Design	241%
Chips and Technologies	175
Quantum	161
Applied Materials	159
Marshall Industries	141
Pyramid Technology	137
Sequent Computer	127
Diebold	124
Western Digital	122
Tandem Computers	122

Source: ELECTRONIC BUSINESS

The biggest decliners

(% drop from 1989)

Perkin-Elmer	74.6%
Micron Technology	59.9
Wang Laboratories	49.0
Ashton-Tate	47.5
LSI Logic	45.9
Sprague Technologies	44.8
Control Data	44.2
M/A-Com	38.8
Measurex	38.1
Cray Research	36.8

Source: ELECTRONIC BUSINESS

T O P

100
CAPITAL
SPENDERS

Rank 1990 1989	Company/Location	1990 capital expenditures	% change from 1989	Capital expenditures as % sales	Fiscal year	Industry segments
1 1	IBM Armonk, N.Y.	\$6,509.0	1.5%	9.4%	12/90	mainframes, diversified
2 3	Motorola Schaumburg, Ill.	1,256.0	14.8	11.5	12/90	communications, semiconductors
3 2	Digital Equipment Maynard, Mass.	1,027.6	-16.0	7.9	6/90	minicomputers
4 5	Hewlett-Packard Palo Alto, Calif.	955.0	11.4	7.2	10/90	diversified, computer-based systems
5 4	Texas Instruments Dallas	909.0	5.4	13.8	12/90	semiconductors, government
6 6	GM Hughes Electronics Detroit	884.3	36.4	7.5	12/90	government
7 9	Intel Santa Clara	679.5	61.0	17.3	12/90	semiconductors
8 7	Unisys Blue Bell, Pa.	460.1	-25.2	4.6	12/90	mainframes
9 8	Xerox Stamford, Conn.	444.0	1.8	3.3	12/90	office equipment
10 10	MCR Dayton	402.0	-4.5	6.4	12/90	mainframes, diversified
11 —	Raytheon Lexington, Mass.	390.7	-5.6	4.2	12/90	government
12 17	AMP Harrisburg, Pa.	338.4	34.2	11.1	12/90	components
13 11	Compaq Computer Houston	324.9	-11.6	9.0	12/90	desktop
14 13	Pitney Bowes Stamford, Conn.	322.7	7.7	10.1	12/90	office equipment
15 21	Advanced Micro Devices Sunnyvale, Calif.	304.2	91.6	28.7	12/90	semiconductors
16 12	Amdahl Sunnyvale, Calif.	303.9	-0.5	14.1	12/90	mainframes
17 22	Tandem Computers Cupertino, Calif.	301.3	121.6	16.1	9/90	minicomputers
18 16	Honeywell Minneapolis	251.5	-6.2	4.0	12/90	diversified, instruments
19 18	Apple Computer Cupertino, Calif.	224.3	-6.1	4.0	9/90	desktop
20 19	Sun Microsystems Mountain View, Calif.	212.9	4.0	8.6	6/90	desktop
21 25	Harris Melbourne, Fla.	193.2	94.5	6.3	6/90	diversified, government
22 —	Litton Industries Beverly Hills, Calif.	191.2	-23.3	3.7	7/90	government
23 15	National Semiconductor Santa Clara	182.0	-34.4	10.9	5/90	semiconductors
24 85	Microsoft Redmond, Wash.	158.1	76.9	13.4	6/90	software
25 14	Wang Laboratories Lowell, Mass.	152.8	-49.0	6.1	6/90	minicomputers
26 23	Tandy Ft. Worth	112.5	-8.1	2.5	6/90	consumer
27 48	Applied Materials Santa Clara	111.1	158.6	19.6	10/90	semiconductor equipment
28 33	Seagate Technology Scotts Valley, Calif.	102.4	31.1	4.2	6/90	peripherals
29 30	Tektronix Beaverton, Ore.	97.1	13.1	6.9	5/90	instruments & measurement
30 37	Conner Peripherals San Jose	94.7	44.0	7.1	12/90	peripherals
31 32	Oracle Systems Redwood Shores, Calif.	89.3	13.1	9.2	5/90	software
32 52	Western Digital Irvine, Calif.	86.5	122.1	8.1	6/90	peripherals
33 28	Data General Westboro, Mass.	85.1	-7.0	7.0	9/90	minicomputers
34 20	Micron Technology Boise, Idaho	79.8	-59.9	24.0	8/90	semiconductors
35 34	Intergraph Huntsville, Ala.	79.6	7.5	7.6	12/90	desktop
36 27	Molex Lisle, Ill.	72.7	-22.6	12.2	6/90	components
37 44	DSC Communications Plano, Tex.	68.1	34.8	13.1	12/90	communications
38 43	Beckman Instruments Fullerton, Calif.	67.3	33.3	8.3	12/90	medical equipment
39 26	Cray Research Eagan, Minn.	62.7	-36.8	7.8	12/90	mainframes
40 42	SCI Systems Huntsville, Ala.	62.7	23.7	5.3	6/90	contract manufacturing
41 24	LSI Logic Milpitas, Calif.	62.0	-45.9	9.5	12/90	semiconductors
42 49	Loral New York	61.2	51.0	4.8	3/90	government
43 38	E-Systems Dallas	60.2	6.2	3.3	12/90	government
44 45	Storage Technology Louisville, Colo.	59.4	17.7	5.2	12/90	peripherals
45 41	Medtronic Minneapolis	55.3	7.7	6.6	4/90	medical equipment
46 —	Varian Associates Palo Alto, Calif.	54.9	12.2	4.3	9/90	diversified, instruments
47 36	Lotus Development Cambridge, Mass.	51.6	-25.1	7.5	12/90	software
48 —	Sequent Computer Systems Beaverton, Ore.	47.3	127.4	19.0	12/90	mainframes
49 57	Maxtor San Jose	44.7	52.8	9.1	3/90	peripherals
50 53	Applied Magnetics Goleta, Calif.	39.9	2.8	10.8	9/90	components

T O P

100
CAPITAL
SPENDERS

Rank 1990 1989	Company/Location	1990 capital expenditures	% change from 1989	Capital expenditures as % sales	Fiscal year	Industry segments
51 35	Control Data Minneapolis	\$38.6	-44.2%	2.3%	12/90	mainframes, diversified
52 41	Analog Devices Norwood, Mass.	38.2	-25.2	7.9	10/90	semiconductors
53 56	Cypress Semiconductor San Jose	36.6	11.3	16.2	12/90	semiconductors
54 —	Savin Stamford, Conn.	36.3	59.5	9.6	12/90	office equipment
55 50	VLSI Technology San Jose	35.3	-10.6	10.9	12/90	semiconductors
56 63	Integrated Device Technology Santa Clara	35.0	31.7	16.7	3/90	semiconductors
57 51	Mentor Graphics Wilsonville, Ore.	34.9	-11.1	8.0	12/90	software
58 71	Teradata El Segundo, Calif.	34.4	77.9	15.3	6/90	mainframes
59 55	Zenith Electronics Glenview, Ill.	32.4	-5.0	2.3	12/90	consumer
60 65	Vishay Intertechnology Malvern, Pa.	30.9	29.9	6.8	12/90	components
61 67	Silicon Graphics Mountain View, Calif.	29.6	27.1	7.1	6/90	desktop
62 47	Novell Provo, Utah	28.1	-35.0	5.7	10/90	software
63 54	Stratus Computer Marlborough, Mass.	27.4	-25.9	6.8	12/90	minicomputers
64 78	Scientific-Atlanta Atlanta	27.4	75.6	4.5	6/90	communications
65 —	Pyramid Technology Mountain View, Calif.	25.8	136.5	14.3	9/90	mainframes
66 66	3Com Santa Clara	25.8	8.7	6.1	5/90	communications
67 75	Andrew Orland Park, Ill.	25.2	54.5	6.9	9/90	communications
68 —	Convex Computer Richardson, Tex.	25.1	64.0	12.0	12/90	mainframes
69 59	Teradyne Boston	23.9	-15.4	5.2	12/90	instruments & measurement
70 69	Computer Associates Garden City, N.Y.	22.8	1.7	1.8	3/90	software
71 96	Diebold Canton, Ohio	22.2	123.9	4.7	12/90	computer-based systems
72 —	Cadence Design Systems San Jose	22.2	241.1	9.6	12/90	software
73 —	Autodesk Sausalito, Calif.	21.1	56.7	8.9	1/91	software
74 87	Archive Costa Mesa, Calif.	21.0	66.8	7.2	9/90	peripherals
75 82	Westmark International Seattle	19.1	36.2	3.9	12/90	medical equipment
76 73	Augat Mansfield, Mass.	17.9	-0.6	6.0	12/90	components
77 —	ESCO Electronics St. Louis	17.6	-19.1	3.3	9/90	government
78 58	M/A-Com Burlington, Mass.	17.5	-38.8	4.7	9/90	government
79 68	Avnet Great Neck, N.Y.	17.4	-22.9	1.0	6/90	distribution
80	Marshall Industries El Monte, Calif.	17.0	140.5	3.1	5/90	distribution
81 89	Watkins-Johnson Palo Alto, Calif.	16.8	42.1	5.4	12/90	government
82 —	Acuson Mountain View, Calif.	16.7	20.8	5.9	12/90	medical equipment
83 —	Quantum Milpitas, Calif.	16.7	160.7	3.7	3/90	peripherals
84 99	Ultimate East Hanover, N.J.	16.5	75.8	7.9	4/90	software
85 64	Measurex Cupertino, Calif.	15.5	-38.1	5.8	11/90	computer-based systems
86 61	Sprague Technologies Stamford, Conn.	15.3	-44.8	4.9	12/90	components
87 81	Symbol Technologies Bohemia, N.Y.	15.3	8.2	6.6	12/90	computer-based systems
88 76	Dynatech Burlington, Mass.	15.0	-5.6	3.5	3/90	communications
89 —	Premier Industrial Cleveland	14.6	11.6	2.3	5/90	distribution
90 39	Perkin-Elmer Norwalk, Conn.	14.4	-74.6	1.7	7/90	instruments & measurement
91 86	Concurrent Computer Tinton Falls, N.J.	14.2	11.8	4.2	6/90	minicomputers
92 97	ADC Telecommunications Minneapolis	13.7	43.1	5.3	10/90	communications
93 77	Datapoint San Antonio	13.7	-13.0	5.1	7/90	communications
94 —	Chips and Technologies San Jose	13.5	175.2	4.6	6/90	semiconductors
95 80	Tellabs Lisle, Ill.	13.4	-6.1	6.3	12/90	communications
96 —	Esterline Bellevue, Wash.	13.4	80.2	3.4	10/90	instruments & measurement
97 100	Diasonics Milpitas, Calif.	12.1	29.8	4.5	12/90	medical equipment
98 92	CTS Elkhart, Ind.	11.8	9.0	4.7	12/90	components
99 70	Ashton-Tate Torrance, Calif.	11.7	-47.5	5.1	12/90	software
100 94	Fluke Everett, Wash.	11.4	8.7	4.9	9/90	instruments & measurement

Home automation finally arrives

New protocols will help chip makers and other electronics suppliers tap into what some see as a \$5 billion-plus market

By Barbara Jorgensen

After a long string of costly, time-consuming false starts, home automation is here.

The vision, according to HA developers, goes something like this: The harried homeowner rushes off to work, leaving the coffee maker on, the VCR unprogrammed for that daytime show, and the security system deactivated. But once at work, she can use a touch-tone phone to turn off the coffee maker—if it's not

already programmed to do so), activate the VCR and security system, and even program the air conditioner to have the house at a pleasant 72 degrees by 6 P.M. The "smart house" might also turn off the lawn sprinkler in the event of rain and run the dishwasher once the laundry is finished.

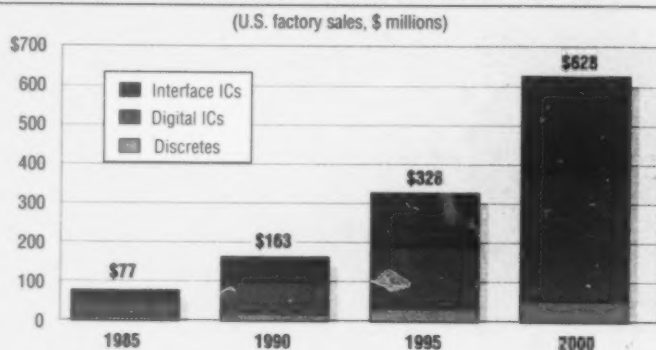
Prototypes of such homes, backed by several partnerships and organizations, already exist. But by the end of this year—for the first time

since the smart house was envisioned a decade ago—several new protocols will bring an unprecedented level of automation to existing and future homes, apartments, and industrial buildings. "Home automation is closer to reality than ever before," says Bill Scheffler, president of the Home Automation Association in Washington, D.C., and national marketing manager for X-10 (USA) Corp., in Newark, N.J.

Reaping many of the rewards of



Home automation semiconductor market



the smart house will be semiconductor makers such as Texas Instruments, Motorola, and Toshiba. But payoffs also will flow to manufacturers of electrical and electronic components, control devices, security systems, computer hardware and software, communications equipment, and appliances.

THE RESULT: a \$5.6 billion market for HA-compatible equipment by the year 2000, predicts Rose Associates, a Los Altos, Calif.-based market research firm. That figure includes hardware and software products for multifunction control systems, user interfaces such as phones and TVs, and communication networks, as well as subsystem markets for security and environmental-control products and services. Researchers at New York-based Frost and Sullivan Inc. predict that annual growth rates of HA-related products will rise from 1.2% last year to 35.4% by 2000.

Does that mean, as some suggest, that HA could create a new generation of consumer electronics for U.S. companies that have lost out to foreign competitors? "I think that is too optimistic," says Scheffler. "Whatever happens in the United States in terms of home-automation standards will be repeated by the Japanese. Or they'll come in with their own standard. Regardless of which

protocol is used, the Japanese will still be building the equipment" because of their strong presence in consumer electronics and more economical manufacturing abilities. Other sources expect to see much of the HA chip manufacturing eventually move offshore as well.

While much of the technology behind HA has been around for years, the market has so far languished for several reasons: high prices, insufficient applications, the lack of a dominant player to provide financial backing and marketing expertise, and a paucity of standards.

That last obstacle will fall in November, when three new protocols—the Electronic Industries Association's Consumer Electronics Bus (CEBus), Smart House L.P.'s Smart House, and Palo Alto Calif.-based Echelon Corp.'s LonWorks—will join X-10, today's de facto HA standard. Although X-10 dates back to 1978, it is a one-way "plug-and-play" communication system; X-10 manufactures the Protector Plus security system, for instance, which can be installed by the consumer. The other three protocols are so-called enabling technologies that allow products and systems to communicate with one another on varying levels. The new protocols are targeted to U.S. markets; Europe and Japan have separate HA standards.

Part of Echelon's system

(LonBuilder, the tools to build LonWorks applications) began shipping in April; half of CEBus's media specs have been released, and Smart House's "Smart Ready" wiring spec is due this month. The Smart House protocol is expected to be the standard for thousands of the million or so new U.S. homes built annually, according to Rose Associates. With the protocols now public, it is up to equipment manufacturers to develop products around one or all of them. The protocols are all incompatible, although not necessarily proprietary—both Smart House and Echelon offer licensing agreements with their technologies, so products can be manufactured for those systems. (LonTalk, part of Echelon's LonWorks package, is actually the protocol.)

Protocol developers paint a rosy picture of the market once the HA concept catches on and target markets go far beyond home buyers. Echelon, in fact, is now targeting OEMs in lighting and building and industrial automation—early customers include Allen-Bradley, Johnson Controls, and Leviton Manufacturing—as well as developing "intelligent" products for the home. AT&T Consumer Products is looking at LonWorks toward that possibility, according to G. H. Hickox, new business director.

IN ADDITION TO X-10, the HA market is now supplied by 20 to 30 vendors, mostly small companies that offer proprietary control and communications systems and integrate them with commercial components and systems. One emerging player is Group Three Technologies in Simi Valley, Calif., which just unveiled its Samantha system for controlling communications, lighting, appliances, security, and other functions. Square D and CSI/Carrier have also released HA systems; Square D's Elan Advanced Home Network, for example, is targeted at integrating home entertainment systems.

The four protocols are divided between two kinds of control—a cen-

tralized control system, with the system's "brain" in one location, and intelligent distributed control, in which systems are interconnected but the failure of one will not affect the others. X-10 and Smart House are centrally controlled; CEBus and

Echelon use distributed control. All can be implemented in varying stages, in entire buildings or parts thereof. Once the protocols are in place, appliances can be added selectively.

Regardless of how simple or so-

phisticated they happen to be, HA systems will depend heavily on semiconductors. Rose Associates predicts that the market for those chips—including discretely, interface ICs, and digital ICs—will grow from \$163 million in 1990 to \$328 million by 1995 and then nearly double again to \$628 million by 2000.

A guide to home automation protocol

CEBus: An open standard being developed by the EIA's Consumer Electronics Group. Its final form is scheduled for release in November and includes specifications for automating a home through five media: power lines, radio frequency, infrared, telephone wiring, and twisted-pair wiring. Its aim is to be retrofittable, have no central brain, and be non-product-specific and expandable. Market: apartments, existing homes. Wiring for CEBus in a 2,400-square-foot home would cost about \$700.

• **Smart House:** A for-profit limited partnership funded in part by the National Association of Home Builders and undergoing an initial public offering. Smart House currently is geared toward new-home construction. Functions will be controlled by a central brain. All products must be Smart House-compatible. Licensed companies will build Smart House products to be marketed and tested by Smart House. Non-Smart House appliances will have basic on-off capability but will not be able to communicate. Additional new home cost: \$7,000 to \$10,000.

• **LonWorks:** A set of technological tools from Echelon Corp. that includes the LonTalk protocol, its Neuron chip, LonWorks transceiv-

ers, and LonBuilder hardware and software tools. Similar to CEBus in not needing a brain. Echelon's target market is OEMs that can use the tools to write applications programs, develop a network, work with the protocol, and embed

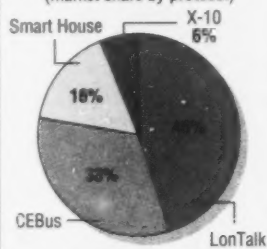
it into the application. It is also usable in Japan and Europe. With a price tag of \$14,000 for LonBuilder alone, the entire LonWorks package is expensive; it targets OEMs in building controls, factory automation, commercial lighting, consumer products, and office automation.

• **X-10:** Established in 1978, currently the de facto HA standard. A simple "plug-and-play" system, X-10 uses a controller and module system. The lowest-priced solution to home automation so far. X-10 (USA) Corp., an OEM engineering and design company, has designed products for General Electric, Advanced Control Technology, Leviton, and Tandy. X-10 is upgrading its offering to smarter products and will eventually offer intracommunications ability.

• **Non-U.S.:** Japan has HBS and Europe D²B. Representatives from Europe, Japan, and the United States are working toward an international home automation standard. □

Who will control the smart home?

(market share by protocol)



Total market by 2000:
\$1.6 billion

Source: Rose Associates

ONE EXAMPLE IS the Neuron chip developed for Echelon by Motorola and Toshiba; capable of communications and control, it could be used in anything from consumer electronics to sprinkler systems. Texas Instruments has a CEBus-compatible chip and is also designing ICs for Smart House. CyberLynx Computer Products in Boulder, Colo., is working with TI on a single-chip CEBus interface that will handle all the details of CEBus communications. And AISI Research Corp. is reportedly shipping early versions of a similar chip called Spirit, an "intelligent" chip that can operate without additional processor power.

The manufacture of HA chips will, for the most part, stay in the United States for at least five years, predicts Rose analyst Doug Schliebus, partly because of protocol differences between the United States and Japan. Future applications for HA chip makers include modems, microcontrollers, and triacs (three-terminal semiconductors with on-off switching capability) for use in HA appliances.

While HA technology is driven largely by semiconductors, virtually every other segment of the electronics industry will get into the act as well. Leading U.S. connector manufacturers Amp Inc. and Molex Inc., for example, are developing wiring, modules, switches, cabling, and connectors for Smart House. Dick Pierce, director of Molex's electronic systems business unit in Lisle, Ill., says licensing by Smart House does not prevent Molex—or any manufacturer—from producing to the CEBus or any other HA protocol. "From our standpoint, the emerging protocols are a tremendous opportunity," says

Pierce. "Molex has to be in a position to take advantage of [home automation]" by developing and manufacturing around the different protocols. He adds that Molex expects revenue from its home and building automation products to top \$300 million over a 10-year span.

Amp has developed cables, connectors, switches, and "smart outlets" for Smart House that provide flexibility for changes, additions, and extensions to the wiring systems. Amp sources expect Smart House electrical/electronic systems to grow at a compounded average annual growth rate of 45% over the decade.

Another high-growth area, projects Rose's Schliebus, is controllers—central units (consisting of the brain, a relay, and interface equipment such as bridges or gateways) that communicate with household products. Although the market for HA controllers in 1990 was only \$600 million, the figure is expected to increase to \$2.3 billion by 2000. The overall compounded average annual growth rate is expected to top 15%, says Schliebus, although whole-house controllers could grow at a rate of 36%.

INTERFACE EQUIPMENT also includes user interfaces such as telephones, remote controls, TVs and VCRs, touch pads, and voice-recognition systems. Interface equipment was worth \$83 million in 1985 but could reach nearly \$1 billion by 2000, growing at an average of 17% per year.

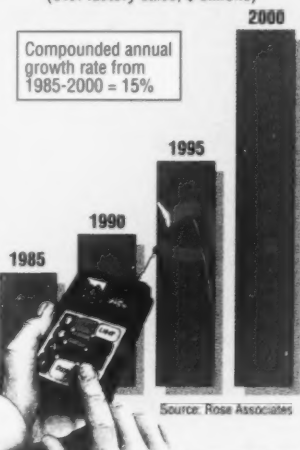
Even electronics distributors stand to gain from HA. Rose Associates reports that some distributors have already started to set procedures and stock products for servicing the new HA systems integrators and installers. Distributors can expect 5% to 10% of their business to come from HA in the next 10 years, says Schliebus. Molex's Pierce expects that distributors will be called upon to kit various components of its Smart House systems.

The incompatibility of the four protocols will also open up niche markets

Home automation equipment market

(U.S. factory sales, \$ billions)

Compounded annual growth rate from 1985-2000 = 15%



for developers of gates, ports, routers, and buses in order to allow interoperability among appliances originally geared toward a specific protocol.

Still, problems exist for each protocol and for the overall HA market, not the least of which is price. Echelon, for example, will not target HA until it can bring its Neuron chip down to the \$2 range; in volume, the chip now costs \$10 and development tools \$14,000. Furthermore, a home designed for the Smart House protocol will cost \$7,000 to \$10,000 more than a conventional home, and the technology is now pegged only to new homes. Retrofit capabilities are being developed by Smart House, according to Smart House L.P. president Chuck Gutenson.

CEBus has been in development for eight years and has experienced numerous delays in releasing its specs. Other problems cited with CEBus include possible interference with AM radio bands, potential security compromises by hackers, and local control of devices so that a CEBus remote doesn't control the neighbor's TV. Critics also point out that CEBus is not a system, so no single organization will develop and market products.

But CEBus developers say that's its advantage: It is a protocol that will allow the user to implement CEBus according to any combination of household media. Homeowners can hook up products one at a time, according to their pocketbooks. France's Thomson Consumer Electronics, for example, is displaying an RCA TV receiver in a CEBus "Bright Home" sponsored by Indiana Power and Light and PSI Energy. Several companies—including Panasonic, Diablo Research, Mitsubishi, Scientific Atlanta, Sony, and Tandy—have been working with the CEBus Committee to finalize the protocol.

X-10, while offering a low-cost solution to HA (its Protector Plus starts at around \$115), is limited by its one-way communication path—it turns a device on, but the user doesn't get feedback to tell if the device is on. Nor can products communicate with one another. According to Scheffler, however, those advances are in development. But since X-10 is an engineering and design company, there is no reason why the company could not develop for a competing standard.

ANOTHER POTENTIAL obstacle for HA is the possibility that manufacturers will hold off on product development until a single standard emerges. But X-10's Scheffler predicts that, as with computers, standards will develop once the products arrive on the market, not the other way around. "You've got IBM, Sun, Compaq, Apple, and so on," he explains. "So far, everybody is surviving. Will it all come together into one system? I don't think so. The consumer will make choices based on what his pocketbook will bear."

Indeed, most manufacturers seem unconcerned about the multiplicity of protocols, as long as they are allowed to develop for or be licensed by any or all of them. Says Smart House's Gutenson, "We all need to get into the market first. Until that happens, it doesn't make sense to pursue compatibility." □